# MPP-E1180: Collaborative Social Data Analysis Assignment 3

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## Determinants of Renewable Energy Investments:

## An EU Cross-Country Analysis

### Introduction

Today it is widely known the fact that climate change imposes real challenges to societies' environmental and economic wellbeing. This state of affairs urges us to think on ways to cope with the effects of climate change as well as finding potential alternatives to the roots of this human-caused phenomenon. Consequently, this pressure has put into question the traditional energy sources in use which have contributed to high levels of pollution and greenhouse gas emissions worldwide. Renewable energy adoption constitutes a means to deal with this challenge and renewable energy sources have been increasingly adopted worldwide for being a consistent way of improving energy efficiency by reducing energy consumption levels. Recent studies of Eyraud et al. (2011) and Del Río, Tarancón, and Peñasco (2014) identified that renewable energy sources will be the key drivers of the energy sector in coming years. Our main goal with this research project is to identify what are the determinants of investments in renewable sources of energy, namely wind and solar power energy sources, across European countries and to what extend factors, such as economic growth, changes in fuel prices, and interest rates have a significant impact on green energy investments.

### Literature Review

According to Eyraud et al. (2011), green investment can be defined as "investments intended to significantly reduce air pollutants and greenhouse gas emissions (GHG), without significantly reducing the production and consumption of non-energy goods". Ilas (2014) shares Eyraud's understanding and use 'green investments' and 'investments in renewable resources' interchangeably.

Two thirds of total carbon dioxide emissions in the world come from the energy sector and their effect on human livelihood is increasingly negative. There are two potential ways of offsetting the impact of such emissions - adaptation and mitigation. While adaptation refers to the efforts to limit human exposure to climate change, mitigation is related to human activities intended to reduce the magnitude of climate change and its impact on human life. Mitigation further involves a two-fold strategy - reduction of carbon dioxide emissions through efficiency gains in energy consumption and production, and the shift to other, cleaner forms of energy production through the adoption of alternative sources.

Romano and Scandurra (2011) analyzes the driving of investments in renewable energy sources in low carbon and high carbon economies. This author argues that there are different ways of assessing the development of renewable energy sources in the literature. One method is to measure the replacement of traditional energy sources in the total energy supply while the other way which is also mentioned by Bird et al. (2005) is to measure the total amount of renewable enegy produced. Each of those approaches were used by Marques, Fuinhas, and Manso (2010) and Carley (2009). Marques et al. use the contribution of renewable to energy supply as a percentage of total primary energy supply while Carley focuses on the yearly electricity generation from renewable energy sources.

By adopting Carley's approach, Romano and Scandurra (2011) conducted a dynamic panel analysis of the investments in renewable sources from 1980 to 2008 in a sample of 29 countries with distinct economic and social structures as well as different levels of economic development. The results of this study show that there is a continuity of investment behavior in those countries that have shown sensitivity towards renewable energy sources. Moreover, it shows that countries with traditionally stable high income tend to show more attention to technologies with lower environmental impact and improved energy efficiency in comparison with fast-growing countries. Authors also concluded that the presence of nuclear power plants, for example, may affect investments in renewable energy sources.

Another interesting study on green investments was conducted by Ilas (2014). The increasing importance of generating cleaner energy as a mitigation measure led the IMF to publish a article in its 2013 Energy Policy Journal containing explanation and trend analysis of the green investments. This research articles served as a bases for Ilas (2014) study on the factors affecting green investments at an international level in which the authors analyzed macroeconomic and political factors in different types of investment in green technologies, including low-emission energy supply, energy efficiency in energy-consuming sectors, and carbon sequestration, in 35 countries from 2000 to 2012. The analysis demonstrated that GDP per capita has a positive impact over investments in green technologies, while GDP growth and variables related to human development capacity as well as technological progress were both statistically insignificant.

Taking into account those previous studies we now aim to verify the determinants of green investments across the 28 countries of the European Union between 2000 and 2015 by adopting a panel data approach. The impact of those determinants over investments in wind and solar energy sources will be estimated in real terms using fixed effects methodology.

## Collected Indicators and Hypotheses

### Source 1: World Bank - World Development Indicators

*GDP per capita (constant 2000 US$)*

Definition: Gross domestic product divided by midyear population. Hypothesis: GDP per capita has an important and positive impact on green investment. They generate a higher demand for energy and clean air. Here GDP per capita is kept constant to correct for domestic inflation and exchange rate fluctuations.

*Energy imports, net (% of energy use)*

Definition: Net energy imports are estimated as energy use less production, both measured in oil equivalents. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

Hypothesis: The energy imports indicator may allows us to verify whether countries have reduced dependence on energy sources from other countries by producing more electricity through its own sources. We expect that a lower energy imports value increases the likelihood of countries to be using electricity generated locally via wind and solar energy sources. /// If a country presents a negative value it indicates that the country is a net exporter./////

*Fossil fuel energy consumption (% of total)*

Definition: Use of energy from fossil fuel as a percent of total energy use. Fossil fuel comprises coal, oil, petroleum, and natural gas products.

Hypothesis: The greater the percentage of energy consumption is the lower will be the incentives for developing installation capacity of renewable energy sources through new investments.

### Source 2: Eurostat

*Innovation in Renewable Energy*

Definition: Number of patents filed for renewable energy/climate mitigation country wise. It comprises energy technologies patent applications submitted to the European Patent Office. Hypothesis: The number of patent applications in renewable energy is used as a proxy for innovation levels having a positive impact on investments in renewable resources.

*Long-term interest rate (10 ys. maturity)*

Definition: Interest rates affect the capital available for investment. Changes in interest rates may impact costs related to access to finance as well as the return on investments. As the realisation of investments especially those related to infrastructure occurs in the long-run, a ten-year maturity interest rate is used in this analysis.
The indicator chosen for this study is the Maastricht criterion bond yields which is used as a convergence criterion for EMU for long-term interest rates (central government bond yields on the secondary market, gross of tax, with around 10 years' residual maturity).

Hypothesis: Higher interest rates imply that business will have less incentives to invest in renewable sources whereas lower interest rates foster long-term investments. In addition, higher interest rates may also increase the costs associated with the generation of electricity from renewable energy sources.

*Electricity from renewable energy sources*

Definition: Electricity generated from renewable energy sources is measured as the percent of gross electricity consumption in the EU-28 countries. It stands for the the ratio between the electricity produced from renewable energy sources and the gross national electricity consumption within a given year. This is the variable over which we build our study on green investments. Electricity generation from wind and solar power energy sources is used as a proxy for renewable energy investments and we expect to verify the effects of the factors presented in this section onto green investments.

**Source 3: OPEC**

*Crude oil prices*

Definition: Crude oil prices represent annual averages of selected OPEC crude oils (OPEC basket). The benchmark for crude oil price is the OPEC Reference Basket. This basket represents the average of prices of petroleum blends produced by OPEC members. Some of these oil blends include, for example, the Saharan Blend from Algeria, Arab Light from Saudi Arabia, BCF 17 from Venezuela, et cetera. OPEC tries to keep the price between given maxima and minima by increasing and decreasing its oil production.

Hypothesis: Crude oil prices can be used as proxy for the demand of energy from fossil fuels. One can assume that a higher price of fossil fuel is positively correlated with investments in renewable energy sources and changes in prices may reveal trends in energy production and consumption. In this sense, we hypothesize that a higher price in crude oil means higher demand, or at least, scarcer availiability of fossil fuels in general, and therefore, it may produce an incentive for countries to invest in renewable energy sources.

## Descriptive Statistics

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## References

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